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Davis et al.

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[54] METHOD AND DEVICE FOR PREPROCESSING STREAMS OF ENCODED DATA TO FACILITATE DECODING STREAMS BACK-TO BACK

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[51] **Int. Cl.**[6] **H04J 3/24**

[52] **U.S. Cl.** **370/389**

[58] **Field of Search** 370/389, 493, 370/496, 498, 535, 536, 537, 538, 539, 540, 541, 542, 543, 474, 476, 477; 348/461, 462, 466, 467, 390, 395, 396, 394, 404, 409, 12, 13, 19, 607, 391, 400, 412, 384

[56] **References Cited**

U.S. PATENT DOCUMENTS

5,612,900	3/1997	Azadegan et al.	364/514 R
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Attorney, Agent, or Firm—Sawyer & Associates

[57] **ABSTRACT**

A method and device for preprocessing streams of encoded data (e.g. compressed in accordance with an MPEG standard) to permit a decoder to decode the streams, back-to-back (i.e., one stream immediately following another), without being reset and without producing video artifacts. The present invention includes verifying that a multiplexed stream complies with an encoding standard and preprocessing packets of the packetized encoded video sequence such that no video artifacts are produced when a video decoder decodes an adjacent encoded video sequence.

17 Claims, 16 Drawing Sheets

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EXHIBIT C

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FIG. 1
(PRIOR ART)

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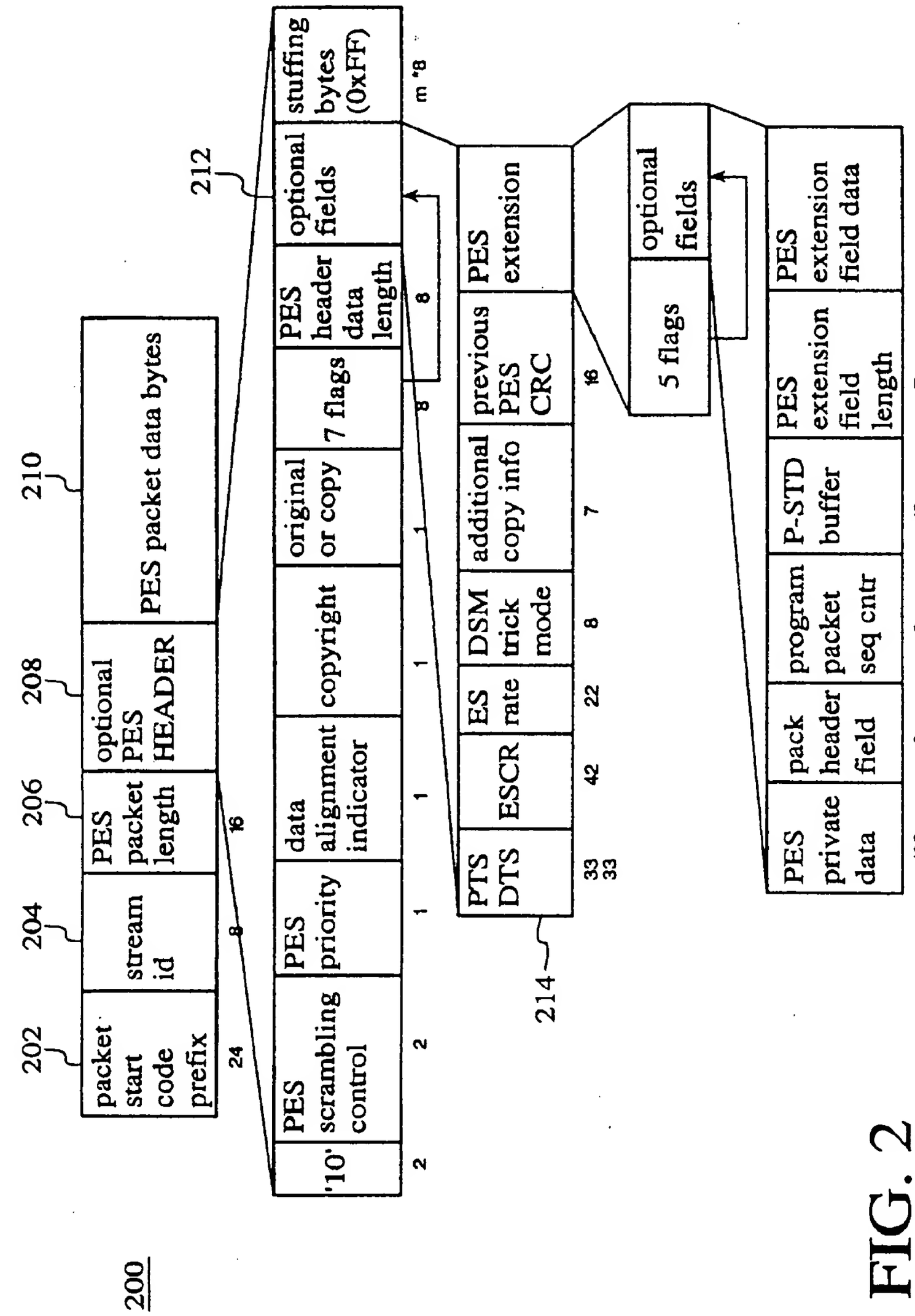

FIG. 2
(PRIOR ART)

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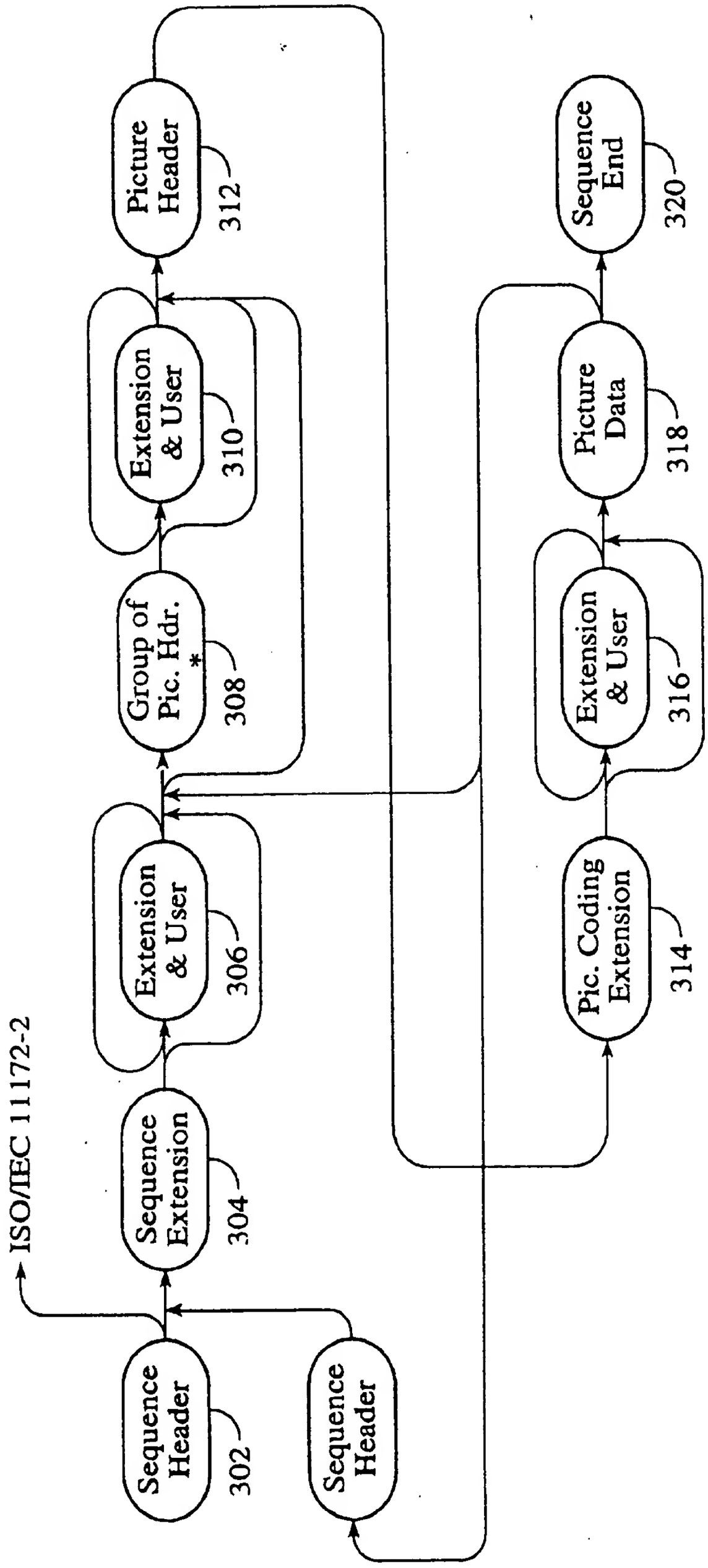

FIG. 3A
(PRIOR ART)

video_sequence0 { 300	No. of bits	Mnemonic
next_start_code0		
sequence_header0 302		
if (nextbits0 = extension_start_code) {		
sequence_extension0 304		
do {		
extension_and_user_data(0) 306		
do {		
if (nextbits0 = group_start_code) {		
308 group_of_pictures_header0		
310 extension_and_user_data(1)		
}		
312 picture_header0		
314 picture_coding_extension0		
316 extensions_and_user_data(2)		
318 picture_data0		
} while ((nextbits0=picture_start_code) ||		
(nextbits0 = group_start_code))		
if (nextbits0! = sequence_end_code) {		
sequence_header0		
sequence_extension0		
}		
} while(nextbits0!=sequence_end_code)		
} else {		
/*ISO/IEC 11172-2 */		
}		
sequence_end_code 320	32	bslbf
}		

FIG. 3B
(PRIOR ART)

FIG. 4
(PRIOR ART)

picture_header0 { 312	No. of bits	Mnemonic
picture_start_code 502	32	bslbf
temporal_reference 504	10	uimsbf
picture_coding_type	3	uimsbf
vbv_delay	16	uimsbf
if(picture_coding_type = 2 || picture_coding_type = 3) {		
full_pel_forward_vector	1	
forward_f_code	3	uimsbf
}		
if (picture_coding_type = 3) (		
full_pel_backward_vector	1	
backward_f_code	3	uimsbf
}		
while (nextbits0 = '1') {		
extra_bit_picture /* with the value '1' */	1	uimsbf
extra_information_picture	8	
}		
extra_bit_picture /* with the value '0' */	1	uimsbf
next_start_code0		
}		

FIG. 5 (PRIOR ART)

group_of_pictures_header0 { 308	No. of bits	Mnemonic
group_start_code ~ 604	32	bslbf
time_code	25	bslbf
closed_gop ~ 602	1	uimsbf
broken_link	1	uimsbf
next_start_code0		
}		

FIG. 6 (PRIOR ART)

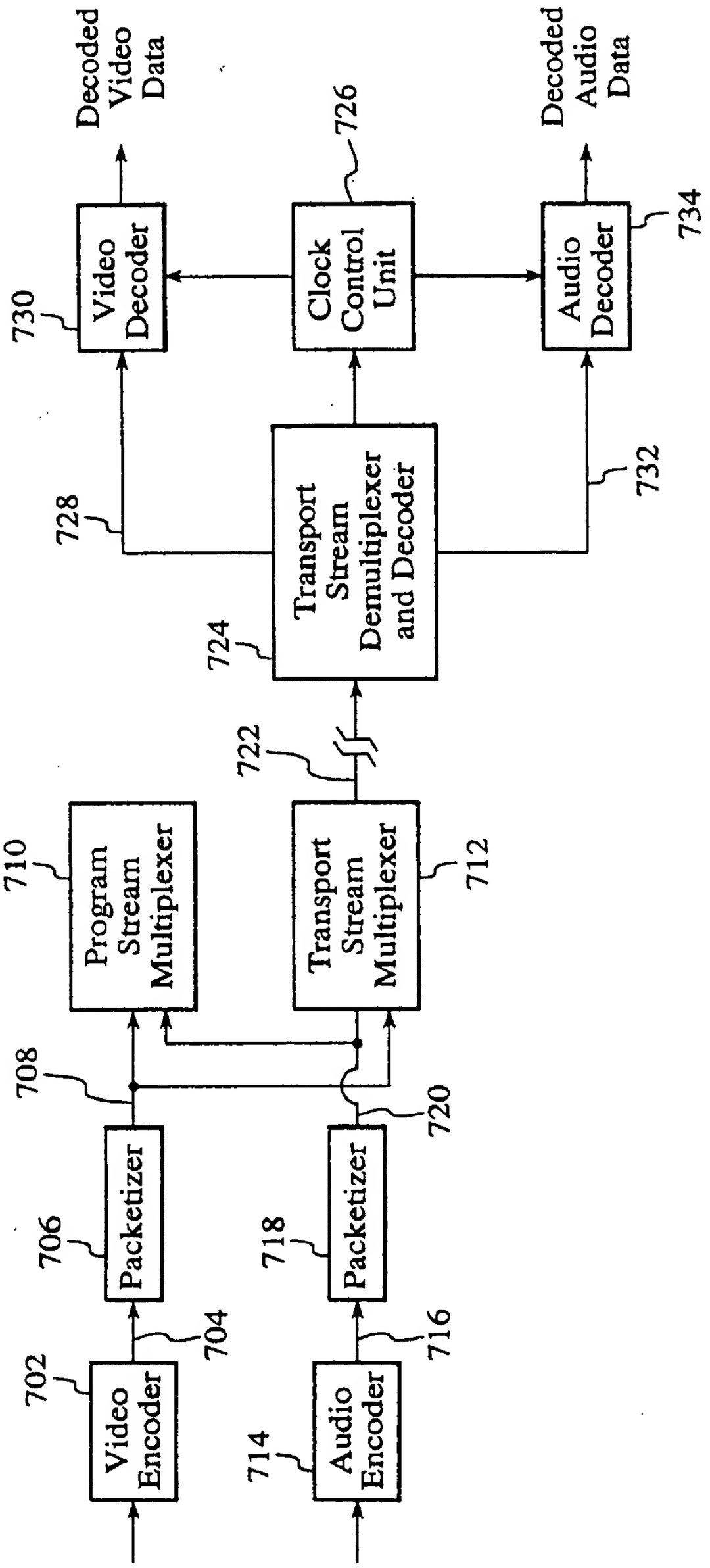

FIG. 7
(PRIOR ART)

FIG. 8

FIG. 9

FIG. 10

FIG. 11
(PRIOR ART)

FIG. 12

FIG. 13

FIG. 14

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FIG. 16

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METHOD AND DEVICE FOR PREPROCESSING STREAMS OF ENCODED DATA TO FACILITATE DECODING STREAMS BACK-TO-BACK

BACKGROUND OF THE INVENTION

a. Field of the Invention

b. Related Art

The MPEG standard focuses on the encoding and transport of video and audio data. In general, the MPEG standard uses compression algorithms such that video and audio data may be more efficiently stored and communicated.

The International Organization for Standardization (or the Organization International De Normalisation) (hereinafter referred to as "the ISO/IEC") has produced the MPEG II standard for the coding of moving pictures and associated audio. This standard is set forth in four documents. The document ISO/IEC 13818-1 (systems) specifies the system coding of the specification. It defines a multiplexed structure for combining audio and video data and means of representing the timing information needed to replay synchronized sequences of the audio and video data in real-time. The document ISO/IEC 13818-2 (video) specifies the coded representation of video data and the decoding process required to reconstruct pictures. The document ISO/IEC 13818-3 (audio) specifies the coded representation of audio data and the decoding process required to reconstruct the audio data. Lastly, the document ISO/IEC 13818-4 (conformance) specifies procedures for determining the characteristics of coded bitstreams and for testing compliance with the requirements set forth in the ISO/IEC documents 13818-1, 13818-2, and 13818-3. These four documents, hereinafter referred to, collectively, as "the MPEG II standard" or simply "the MPEG standard", are incorporated herein by reference.

FIG. 7 is a high level block schematic showing a system for encoding, communicating, and decoding video and audio data in accordance with the MPEG II standard.

The transport stream multiplexer 712 multiplexes the encoded audio and video packets to form a transport stream 100 and provides the transport stream 100 to communications link 722. At a remote end of the communications link 722, a transport stream demultiplexer 724 receives the multiplexed transport stream 100.

As mentioned above, transport streams 100 permit one or more programs with one or more independent time bases to be combined into a single stream. That is, a transport stream 100 may include a first program and a second program. In presently contemplated systems, both the video decoder 730

and the audio decoder 734 must be reset before decoding a next program, for reasons which will be explained below. Thus, for example, in such systems there must be a temporal gap (e.g., one second) between the decoding of the first and second programs to permit the video and audio decoders 730 and 734, respectively, to be reset. This temporal gap precludes the playing of the second program directly following the first program. Moreover, it is difficult to determine when one program ends and another begins in real-time. Thus, a method and/or a device is needed to permit more than one program to be played (i.e., decoded) back-to-back. The method and/or device should also overcome, or avoid, the difficulties of determining program boundaries in real-time.

Thus, as can be appreciated from the above discussion of MPEG and MPEG II video encoding, the video decoder 730 often needs past and future frames to decode a picture (B-Picture) frame. If the last temporal (displayed) frame of a first program is used in decoding a first temporal (displayed) frame of a second program, or if a partial video frame is used, the output of the video decoder 730 will have been improperly decoded, disadvantageously causing video artifacts. Thus, as discussed above, the decoders must be reset between programs in known systems.

SUMMARY OF THE INVENTION

Specifically, the present invention provides a method for preprocessing multiplexed streams of packets of packetized, encoded, audio and video sequences such that an audio decoder can decode the encoded audio sequence to produce an audio sequence and a video decoder can, without being reset, decode the encoded video sequence to produce a video sequence. The method of the present invention (i) verifies that the multiplexed stream complies with an encoding standard, (ii) preprocesses packets of the packetized, encoded, video sequence such that no video artifacts are produced when the video decoder decodes an adjacent encoded video sequence, and (iii) preprocesses the packets of the packetized, encoded, audio data sequence such that its start time is within a first predetermined time of the start time of the video sequence and its temporal length is within a second predetermined time of the temporal length of the video sequence.

The step of preprocessing the packets of the packetized, encoded, video sequence preferably includes (i) deleting any video frames that cannot be decoded if video frames of the video sequence are not temporally correct, and (ii) deleting any video frames following a code indicating an end of the encoded video sequence. The step of preprocessing the packets of the packetized, encoded, audio sequence preferably includes (i) removing any partial audio frames, (ii) adjusting (i.e., adding or deleting) the number of audio frames, if necessary, such that the audio and video sequences start within the first predetermined time, and (iii) adjusting (i.e., adding or deleting) the number of audio frames, if necessary, such that the temporal lengths of the audio and video sequences are within the second predetermined time.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 2 is a diagram which illustrates the syntax of an MPEG II PES packet.

FIGS. 3*a* and 3*b* illustrate the organization of an MPEG II video sequence.

FIG. 4 illustrates the structure of a sequence header of the MPEG II video sequence of FIGS. 3*a* and 3*b*.

FIG. 5 illustrates the structure of a picture header of the MPEG II video sequence of FIGS. 3*a* and 3*b*.

FIG. 6 illustrates the structure of a group of pictures header of the MPEG II video sequence of FIGS. 3*a* and 3*b*.

FIG. 7 illustrates an encoding, transmission, and decoding system envisioned by MPEG II.

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